XLIX.—*Investigations upon the Structure and Natural History of the* Vorticellæ. By Dr. Richard Greef.

[Concluded from p. 397.]

The Contractile Reservoir of the Vorticellæ.

In many Vorticellæ, especially in *Epistylis flavicans*, *Carchesium polypinum*, &c., I have been able to observe the *rosette-like canal-system* ascribed by Stein* to many other Infusoria; but, as a rule, I could only see it very distinctly when the contractions were rendered slow by pressure &c. At the commencement of the systole, just as Stein describes, bubble-like vesicles make their appearance round about the margin of the reservoir; and these, as the central reservoir becomes smaller, acquire a *rosette-like* grouping, in which, however, the individual vesicles are not generally all of the same size, whilst during diastole they coalesce again into a single vesicle. Sometimes I have thought that I could observe a communication between the contractile reservoir and the initial portion of the alimentary tube (vestibulum), in the vicinity of which the former is always situated; but I could never attain to certainty upon this point.

The contractile reservoir of the Vorticellæ is always situated within the cortical layer of the body, pretty close to the external cuticula; it has a definite position here, which remains unaffected by the currents of the general contents of the body—a further indication that the cortical layer forms a firm parenchyma, which takes no part in the current of rotation, as otherwise the contractile vesicle, as also the other organs already mentioned with respect to this point (nucleus, alimentary tube, &c.), must also constantly change its position.

In *Carchesium polypinum* there is a very peculiar organ, which, so far as I know, has not yet been described, and which may take its place here provisionally, because it always adheres to the contractile reservoir. It is, like the latter, a vesicular but not contractile space, covered throughout its whole periphery with fine, short, straight bacilli, which, apparently, lie in a tangential direction to the surface (Pl. XIV. fig. 9, *r*). The bacilli, however, can be observed only in the fresh state, *i. e.* in the living animal; when the Vorticellan is dead, or too strongly compressed, they become indistinct, or entirely disappear; sometimes also I have missed them even in uninjured individuals, whilst the organ under notice is itself never wanting. Its inner space seems to contain a hyaline fluid, which, however, does not always entirely fill it, so that indentations and processes are often produced on its surface.

* Der Organismus der Infusionsthiere, i. p. 88.

Sometimes I thought I could detect a connexion with the contractile reservoir, sometimes, as in the case of the latter, a union with the initial portion of the alimentary tube—that is to say, an opening into it; but I was unable to arrive at any certain information upon this point, as, indeed, upon the significance of the whole structure.

Reproduction and Development of the Vorticellæ.

The asexual reproduction of the Vorticellæ by fission is one of the oldest observations of the kind upon the Infusoria and lower animals in general, and has been confirmed times out of number. In all Vorticellæ (if we except the genus *Lagenophrys* belonging to the Ophrydinæ, which increases, according to Stein, by diagonal fission), it occurs as longitudinal fission, and, indeed, as a division into two more or less completely similar halves. The introduction to fission is always that the Vorticella retracts the ciliated organ into its interior, contracts the peristome firmly over it, and remains in this contracted, spherical condition for some time, during which the contractile-stalked forms repeatedly spring back. Soon after this the spherical form is seen to become flattened from before backwards, whilst the lateral parts gain in extension (Pl. XII. fig. 1). At the same time the cord-like nucleus places itself transversely—probably, in the first place, because the whole body is drawn out to the right and left; and the contractile reservoir is also driven to the median longitudinal axis (Pl. XII. figs. 2 & 8). Now the constriction commences. First of all we see a slight depression make its appearance in the middle of the anterior surface of the body (Pl. XII. fig. 1); and this is soon followed by an emargination on the posterior base of the body attached to the peduncle. The two constrictions, occupying the two longitudinal poles of the body, advance towards each other, so that the whole body is soon surrounded by a median longitudinal annular furrow, which in the first place divides the surface into two equal lateral halves (Pl. XII. figs. 2 & 8). This annular furrow cuts in deeper and deeper, whilst the jerking back by means of the peduncular muscle is more frequently repeated, by which the contractions and the whole process of constriction are evidently forwarded. The nucleus, the contractile reservoir, the ciliated organ, and the peristome are drawn in to take part in the act of fission; and finally, when the two halves are completely separated, and only connected at their base by the peduncle, each fissional scion has almost completely the organization of the parent animal, and does not even differ greatly

in size from the latter. Owing to the continual strong contraction of the body, however, it is difficult to ascertain how the alimentary tube behaves in the act of fission; but at any rate each half receives one or the other section of it, replacing the deficient portion by new formation. In the Vorticellæ which do not form stocks, as is well known, only one of the fissional scions remains upon the parent stalk, or in the parent cell; the other separates completely after it has formed what is called the posterior circlet of cilia, which commences by a transverse annular furrow making its appearance at the posterior end of the body where the conical base passes into the bellied bell-shaped portion, and afterwards becoming a cushion-like ridge. Upon this ridge the circlet of cilia is developed (Pl. XII. fig. 3, *h*).

Besides bifission, a second kind of asexual propagation has been described among the Vorticellæ, and, indeed, long ago, namely by Spallanzani and others in the last century. This is a formation of buds, by which a comparatively small portion of the body of the parent is pushed out in the form of a bud at the side walls, and gradually constricted off as a new scion. Stein has the merit of having furnished the very interesting proof that these bud-like structures observed on the bodies of Vorticellæ are in reality *not buds* (that is to say, *products of their bearer*), but small fissional scions produced by the several times repeated longitudinal fission of other individuals, which swim from without to the larger individuals, and attach themselves to their lateral walls, becoming united with them, and thus completing an "act of conjugation." Stein has traced this extremely remarkable process by a series of careful investigations, and named it *gemmiform conjugation*.

It would carry us beyond the purpose of this little memoir if we were to follow, even in abstract, Stein's series of observations on gemmiform conjugation and the reproduction of the Vorticellæ in general, which have been treated by him with the most minute detail, but unfortunately are still entirely unillustrated by figures, which would facilitate our comprehension of them. I will therefore for the present confine myself to presenting briefly my own observations in comparison with Stein's, in the hope of being able, hereafter, in continuation of this, to offer something further, as, with regard to both the Vorticellæ and other Infusoria, there is still much obscurity that requires clearing up; or at least the clearness which Stein supposes to have been attained is far from existing. It is only by the most many-sided and unprejudiced observations both of the Infusoria and of the other sections of the Protozoa, without at once drawing from every detail far-reaching general

conclusions (which often rather hinder than forward knowledge), that it may be possible to separate those things which really belong to the cycle of reproduction from other phenomena, and to group them together so as in time to obtain a fixed point of view.

In the first place I have been able in many cases to confirm the important observation of Stein that the gemmiform appendages of the Vorticellæ are not products of their supporters, or true buds of them, but smaller individuals penetrating from without and uniting with them, and that, consequently, throughout the Vorticellæ, no reproduction by gemmation or sprouting seems to occur.

The first observations relating to this point were made several years ago during a sojourn in the North Sea (at Ostend) on a marine form which is abundant there, usually adherent to Algæ. In this Vorticellan I was at once struck by the comparatively very frequent occurrence of bud-like structures on the lateral walls of the individual animals, these otherwise in general only rarely coming under observation. In the above-mentioned Vorticella, which differs in its whole habit from the marine *Vorticella patellina* of Ehrenberg, found by him near Wismar, in the North Sea, and therefore may probably be a distinct species, I was able to trace the whole process of the so-called gemmiform conjugation, step by step, as I have represented it in Pl. XIII. figs. 1–7. In fig. 1 a small individual furnished with the posterior circlet of cilia has swum up to a larger one. The ciliary organ is retracted, and the conical base directed perpendicularly towards the lateral walls. Thus we see the smaller individual creep about upon the surface of the larger one by means of the cilia, which are constantly in undulating movement, sometimes skipping up and down, sometimes creeping round it, and apparently feeling and seeking everywhere. In spite of the frequent jerkings back of the larger individual, which seem as though it was trying to escape from the irritations produced by the intruder, the latter obstinately persists in holding the position which it has once selected. Even if it is now and then shaken off for some distance by a sudden and violent jerking, it makes its appearance again the next moment, always swimming again upon the same animal in order to renew its attacks. After some time we observe that the conical base of the smaller Vorticella, which previously projected acutely, becomes retracted, so that a posterior pit is produced, which then frequently sinks so deeply that the posterior circlet of cilia is also retracted or borders the margin of the pit. This pit serves as a *sucking-disk*, with which the

animalcule now adheres to the side walls of the other, for which purpose a position on the hinder part of the body, nearly corresponding to the bottom of the body-cavity, is generally selected (Pl. XIII. fig. 2).

After a short time the smaller Vorticella adheres firmly to the larger one, so that, if the process has not been traced, one supposes one sees a bud-formation. By careful examination, especially with the aid of cautious compression, we now make the further interesting observation that the conical base which was at first retracted to form the sucking-pit is again extended, and serves as an organ for boring into the subjacent side wall of the larger Vorticella (Pl. XIII. fig. 3). The conical process thus formed gradually penetrates deeper and deeper; and this is the introduction to a complete amalgamation of the two individuals. The intervening walls are absorbed, and soon there is an unobstructed communication between the two body-cavities. The pressure exerted in this process is so strong that we frequently see clear, bead-like drops of parenchyma make their appearance at the margin of union (Pl. XIII. fig. 4). The bud-like structure now contracts or shrivels more and more, its contents being, as it were, sucked up by the large Vorticella; so that finally there is only left on the side wall a tubercle with a small external aperture, the contours of which pass directly into those of its bearer, and in which we can no longer recognize the Vorticellan form and organization. In this way in course of time the whole contents of the small Vorticella pass into the larger one; and at last only a more or less thin lobe projects from the wall of the latter, evidently the contracted and shrivelled empty skin of the former bud-like individual (Pl. XIII. fig. 6, *k*). This lobe is usually apparently beset all round with fine hairs or bristles, which, however, are probably only the expression of the numerous foldings of the originally annulated integument. Finally the lobe itself is constricted off, and often remains connected with its supporter only by a thin tenacious filament (fig. 7, *k*), until this also is torn by a sudden jerking back of the Vorticella, and the lobe is cast off, by which the process of amalgamation of the two individuals is completely finished.

I must expressly remark that, notwithstanding I have repeatedly sought for them, I have never observed in this marine Vorticellan the so-called *rosettes* of fissional scions produced by rapidly continued division, but always only bifissions, although these, singularly enough, are remarkably frequent in combination with the bud-like amalgamation. It is, therefore, not to be supposed that the smaller individuals,

which, however, are sometimes but little inferior in size to those selected for union, had proceeded from simple bifission without rosette-formation. Moreover I have not observed the action on the nucleus described by Stein in this form, but have limited myself to the above-described external phenomena of the act of union.

In freshwater Vorticellæ, however, especially from the Poppelsdorf Castle-pond near Bonn, I had abundant opportunity of observing both the rosette-formation of the fissional scions and the internal processes arising from the gemmiform amalgamation. In the first place, it was again in an animalcule belonging to the genus *Vorticella* (*Vorticella campanula*?), which is characterized by a comparatively large body and an unusually long peduncle (Pl. XIII. fig. 8), that I found many gemmiform unions. In that represented in fig. 8 an open union of the two body-cavities and a complete external amalgamation had already occurred. The body-cavity of the smaller Vorticella (*k*) was filled with oval, sharply contoured, dimly shining corpuscles which passed through the interior with *a brisk skipping motion*, and also repeatedly passed over into the larger Vorticella. I could not perceive a nucleus in the gemmiform appendage. The body-cavity of the other individual, however, was filled with comparatively large corpuscles, also of an oval form and sharply circumscribed, which strikingly resembled hard-shelled ova. Here also I could perceive no nucleus. It seems probable, therefore, that, in accordance with Stein's observations, we may regard the two different bodies in the bud-like individual and its supporter as produced by the breaking up of the nucleus in consequence of the "gemmiform conjugation." I have been unable, however, to observe any further development of these bodies, as material of the same *Vorticella*, afterwards obtained, showed no trace of gemmiform unions.

The remarkable *rosettes*, and the bud-like individuals which separate from them and unite with the larger Vorticellæ, were first of all repeatedly observed by me in *Epistylis flavicans*. The rosettes occurred as groups of from four to eight individuals; and we may often see several rosettes at the same time upon one stock (Pl. XV. fig. 1, *r*, *r*, *r*, *r*). The groups often remain together in the form of a rosette without being in direct, firm union either with each other or with the stock, their conical bases converging towards one another, and being held in companionship by constant undulation of the posterior circlet of cilia. Besides these, I also met with many gemmiform unions, but without succeeding in observing the internal phenomena possibly connected therewith.

I was enabled most definitely to observe both the external circumstances (*i. e.* the rosette-formation and gemmiform unions) and the inner changes of the nucleus accompanying or rather proceeding from these, in *Carchesium polypinum*.

In the first place, in the nucleus, which, in *Carchesium polypinum*, is usually very long and bent and twisted like a worm (Pl. XIV. fig. 1, *n*), I frequently saw appear those clear, usually double-contoured, nucleoles which Stein had previously observed in *Vorticella microstoma*, and which often produce the impression of nuclei with large nuclear corpuscles (fig. 2). In others the whole nucleus was broken up into separate segments of a roundish or oval form, which, however, were still surrounded by the common membrane of the nucleus, and also placed together in the form of the original nucleus (fig. 3). In the interior of the individual segments, again, there were several of the above-mentioned nucleoles (fig. 3, *l*). Lastly, in other individuals the membrane of the nucleus was evidently broken through, and the whole contents evacuated into the body-cavity. Sometimes larger and smaller oval or round disks representing the nuclear segments (Pl. XIV. fig. 4), but containing a comparatively far larger number of nucleoles than before, swam about—sometimes individual nucleoles already separated from the common envelope, and then sometimes enlarged three or four times. The larger nucleoles, especially when oval, again produced exactly the impression of hard-shelled ova (Pl. XIV. fig. 4, *a*).

In discussing the above observations I must in the first place remark that by these, as by Stein's observations, I have not attained to any complete and clear insight into the signification of the "gemmiform conjugation," as Stein called it, and therefore do not at present venture to append to them definite ideas and consequences, as Stein has done, especially as I have detected exactly the same alterations of the nucleus which I have described above, on the whole in accordance with Stein, as the results of gemmiform union, where I could not discover, either on the individuals in question or in the whole colony of *Carchesium*, any external trace of gemmiform unions, which of course does not exclude the possibility that such unions may have previously taken place. Stein even goes so far as to assume that, by swarming forth, such individuals of the stock as have completed the gemmiform union, and in consequence of this are filled with the products of the nucleus (called by him the *placenta*), might give origin, by adhesion and renewed colonization, to the building up of an entire stock, the individual members of which, of course produced by bifission from those first formed, are all provided

with placental disks. This, however, is only a more or less probable supposition, which, for the present, is destitute of that support of actual observation which alone could prove it.

Moreover, in one and the same species, namely *Epistylis flavicans*, besides the gemmiform unions, I have made extremely remarkable observations of another kind, which also indicate a mode of reproduction, but of a very different nature. These may be briefly noticed here at the close of this communication. Like most of the Vorticellæ, *Epistylis flavicans* possesses a cord-like nucleus, bent more or less into a horse-shoe shape. Frequently this nucleus, in all the individuals of the stock, is filled only with a finely granular and otherwise homogeneous parenchyma (Pl. XV. fig. 10); but sometimes the nuclei of *Epistylis flavicans* exhibit very remarkable alterations. In the first place we sometimes find individuals, almost always several upon the same stock, the nucleus of which is considerably thickened, but at the same time shortened, so as to acquire the form of a somewhat crooked sausage, which, by its dark contents, shows sharply from the interior, and therefore catches the eye even under a low power and in the living and moving animals (Pl. XV. fig. 9). If the nucleus of this form be examined more closely, and with a higher power, we see that it acquires its dark appearance from a mass of capillary structures with an undulating course, which give the whole organ the appearance of being filled with a ringlet-like mass of filaments resembling spermatozoids (Pl. XV. fig. 5, *n*). No movement can be detected in them. If this substance be isolated by tearing or bursting the nucleus, we find that it consists of nothing but capillary bacilli, slightly curved in a sickle-like form, which appear to be a little dilated at one end and pointed at the other. All are rigid, dimly shining, and sharply defined (Pl. XV. fig. 6). These, no doubt, are similar structures to those first found by Johannes Müller and his pupils Claparède, Lachmann, and Lieberkühn, and afterwards by Stein, Balbiani, and others, in the nucleus and nucleolus of many other Infusoria, and which have subsequently been regarded as the spermatozoids of the Infusoria. One is very much inclined, in the present case, to regard the structures in question in *E. flavicans*, from their whole mode of occurrence and appearance, as spermatozoids. However, especially taking into consideration the "gemmiform conjugation" which occurs in this species also, I do not venture at present for my own part to treat these as the spermatozoids of the Vorticellæ, as has already been done by others, perhaps too definitely, although, of course, I am no more inclined to accept the second supposition, that they are parasitic structures.

In the same colonies of which some animals bear a nucleus with the above-described hair-like structures, there are others the nucleus of which has retained the ordinary elongated, horseshoe-like form. But on closer examination we observe, even in these, very noteworthy alterations, which, when we pass under review a series of different individuals, show a certain gradational sequence. The first stage appears to be that, in the midst of the nucleus, a clear, irregularly formed, and often repeatedly interrupted longitudinal axis makes its appearance (Pl. XV. fig. 11). In a subsequent stage this longitudinal axis is seen as a uniform cord, filled with dark granules, passing through the substance of the nucleus (fig. 12), so that, especially taking into consideration the following structures, one is vividly reminded by it of the rhachis of the Nematoda. Further investigation shows us the axial cord surrounded by large pale nucleoles, which have apparently sprouted from the former (fig. 13). These nucleoles constantly increase in number with a gradual increase in size (fig. 14), so that finally they occupy nearly the whole of the nucleus. Subsequently I have fancied that I detected such nucleoles also floating in the body-cavity, but have been unable to arrive at any certainty upon this point.

It is indeed very seductive to express the opinion, which might be supported by many analogies with other observations, that the above-described phenomena in the nucleus stood in connexion with the spermatozoid-like structures in the nucleus of other individuals—in other words, that we are here in presence of a sexual reproduction in the Infusoria, and this not merely brought about by special organs to be regarded as ovarium and testes, but even by these organs being distributed upon different individuals of the same stock, so that these animals are of separate sexes (monœcious). But, with reference to the above remarks, I prefer in this case also simply to communicate the discovery, leaving a decision upon it for further investigations.

It seems, however, to be beyond doubt that both the organization and life-history, not only of the Vorticellæ, but of the Infusoria in general, are comparatively rich and highly developed, but that only a little of it has hitherto been deciphered with certainty—and that Ehrenberg, although he may have erred much in details, especially in the interpretation of the organs and structures first seen or discovered by him (and this must be borne in mind), nevertheless, on the whole, supported by his extended and indefatigable investigations and abundant observations, has recognized with just tact and acuteness the high organizational value of the Infusoria.

EXPLANATION OF THE PLATES.

Plate XII.

Figs. 1–6. Representation of the asexual propagation by bifission of *Vorticella marina* (sp. n.?).

1. Commencement of the division by retraction of the ciliated organ and contraction of the whole body, with increase of the transverse diameter.
2. Segmentation and gradual deepening of the constriction which divides the body into two similar halves: the nucleus (*n*) and contractile vesicle are divided at the same time.
3. Division completed: one fissional scion is separating from the peduncle and forming the posterior circlet of cilia (*n*).

4, 5, & 6. Free, swarming fissional scions.

Figs. 7–11. Fission of *Cothurnia imberbis*.

7. The animal retracted within its envelope.
8. Constriction into two halves.
9. One fissional scion separating from the envelope and forming the posterior circlet of cilia (*n*).

10 & 11. Fissional scions which have swarmed out of the envelope.

Fig. 12. Single *Cothurnia* extended out of its envelope: the arrows indicate the current of rotation in the interior; the cuticula shows a distinct transverse annulation.

Plate XIII.

Figs. 1–7. Representation of the various stages of "gemmiform conjugation" in *Vorticella marina*: *k*, the bud-like Vorticella; *l*, contractile vesicle.

1. The bud-like fissional scion (*k*) furnished with the posterior circlet of cilia has attached itself to a larger Vorticella for the purpose of conjugation.
2. The conical hinder part of the body of the bud-like Vorticella is retracted, and the base thus converted into a sucking-cup.
3. The union is completed by means of this sucking-cup.
4. The pressure during the amalgamation, which is constantly becoming firmer, is so strong that bead-like drops of parenchyma make their appearance round about the point of union.
5. The bud-like Vorticella has become contracted into a mere tubercle.
6. The contents of the bud-like Vorticella have completely passed into the larger Vorticella, so that merely the external sac of integument remains projecting from the latter as an empty lobe.
7. The cutaneous lobe is thrown off after some time: the spinous appearance usually observable upon it is produced by the collapsed, annulated cuticula.

Fig. 8. Gemmiform conjugation in *Vorticella campanula* (see p. 467).

Plate XIV.

Fig. 1. *Carchesium polypinum*: *m*, mouth; *b*, contractile vesicle; *n*, nucleus; *k*, bud-like scion in the act of attaching itself to a larger Vorticella; *s*, nucleiform corpuscles arranged in longitudinal series following the course of the muscles.

Fig. 2. Nucleus of *Carchesium polypinum* after gemmiform conjugation: *e*, nuclei.

Fig. 3. The nucleus broken up into separate segments, as a further effect of gemmiform conjugation.

Fig. 4. The segments of the nucleus (*placenta*, Stein), and in part also the nucleoles contained in them, have escaped from the common nuclear envelope, and are driven about freely in the body-cavity of the Vorticella: 4 *a*, free larger nucleoles of the nuclear segments.

Fig. 5. *Epistylis minuta*, sp. n. The whole stock shown magnified about 400 diameters.

Fig. 6. *Zoothamnium alternans* (North Sea).

Fig. 7. A single branch of *Zoothamnium alternans* with two small individuals, more highly magnified.

Fig. 8. The conical base of the body of *Carchesium polypinum* seen from below (in transverse section). The circles of granules indicate the lumina of the muscles of the body and peduncle.

Fig. 9. Representation of the course of the ciliary spiral in *Carchesium polypinum*: *s*, commencement of the spiral; the arrows indicate the course of the spiral from the right of the buccal orifice towards the left, to penetrate, after one circular turn (*w*), in a curve into the vestibulum; *p*, the outer peristome; *v*, entrance into the vestibulum (buccal orifice); *g*, the long seta projecting from the vestibulum; *a*, anus; *b*, contractile vesicle; *r*, the non-contractile receptacle, covered with bacilli (see p. 462).

Plate XV.

Fig. 1. *Epistylis flavicans*, under a low power: *r*, rosettes of fissional scions; *k*, gemmiform conjugation.

Fig. 2. The posterior extremity of the peduncle of *Epistylis flavicans*, more highly magnified (300–400 diam.).

Fig. 3. *Epistylis flavicans* seen from the point of junction with the peduncle. The fibres radiating from the peduncle indicate the longitudinal muscles, and the concentric circles the transverse annulation of the skin.

Fig. 4. Transverse section of the peduncle of *Epistylis flavicans*.

Fig. 5. *Epistylis flavicans*, magnified 300 diam.: *n*, nucleus filled with spermatozoid-like corpuscles; *k*, paired capsules with rolled-up threads in their interior (urticating capsules?) situated under the skin; *g*, the longitudinal fibres (muscles) and transverse striæ of the cuticula (compare fig. 3).

Fig. 6. Isolated spermatozoid-like bodies from the nucleus of fig. 5, magnified about 800 diam.

Fig. 7. Isolated (urticating) capsules, more highly magnified: *a*, with the threads rolled up in the interior; *b*, with protruded threads.

Fig. 8. The same, magnified about 300 diam.

Fig. 9. A branch of *Epistylis flavicans* with two individuals, of which the dark prominent nucleus is filled with spermatozoid-like bodies.

Figs. 10–14. Development of nucleoles (germ-granules) in the nucleus of *Epistylis flavicans*.

10. Nucleus filled with finely granular substance, in which no further form-constituents are recognizable.
11. A clear longitudinal axis, still consisting of separate pieces, runs through the middle of the nucleus.
12. The longitudinal axis is continuous and filled with dark granular substance.
13. Nucleiform structures issue from the longitudinal axis, finally enveloping it.

Fig. 14. The longitudinal axis of the nucleus entirely filled with granules.
Fig. 15. Bud-like scion from a rosette of *Epistylis flavicans*, magnified about 300 diam.: *n*, nucleus; *b*, contractile vesicle.
Fig. 16. Encysted *Epistylis flavicans.*
Fig. 17. Branch of *Epistylis flavicans* on which the nuclear formations described under figs. 10-14 occurred. For distinction from those of fig. 9 the nuclei are not visible.
Fig. 18. Large variety of *Epistylis flavicans*: *x*, the parasitic (?) Flagellata seated on the peduncle.
Fig. 19. The parasitic (?) Flagellata under a higher power.

PLATE XVI.

Fig. 1. Representation of the alimentary system of *Epistylis flavicans.* The animals have been subjected to a carmine diet. The arrows indicate the current of rotation of the coloured material (balls of nutriment) in the interior of the digestive body-cavity: *m*, buccal orifice (entrance into the vestibulum); *o*, œsophagus; *v*, funnel-like termination of the œsophagus; *d*, canaliform continuation of the funnel. The colour-balls issuing from the funnel glide as spindle-shaped bodies (*b*) through the canal, and project at *b'* with a little knob from its hinder opening; *n*, nucleus.
Fig. 2. The alimentary tube of *Epistylis flavicans* isolated. The arrows indicate the direction of the flow of the food: *m*, mouth; *k* & *k'*, valvular partitions; *o*, œsophagus; *v*, funnel; *d*, canaliform continuation of the funnel; *h*, anus, from which a long seta projects outwards.
Fig. 3. Alimentary apparatus of *Epistylis plicatilis.*
Fig. 4. Branch of *Epistylis plicatilis*: *k*, contracted animal; *n*, nucleus with nucleoles; *b*, contractile vesicle; *g*, muscles.
Fig. 5. Posterior adherent extremity of the peduncle of *Epistylis plicatilis*: *f*, foot with sole.

L.—*On Indian Mud-Tortoises* (Trionyx).

By Dr. J. E. GRAY, F.R.S. &c.

BEFORE I saw the 'Annals' of last month, I was told that Dr. Anderson had examined nearly two hundred specimens of Indian mud-tortoises. I observed that I supposed he had availed himself of my suggestion, and was about to give us a paper worthy of his position in the Museum and University. But when I saw the paper, this delusion was dispelled. The paper might be shortly written thus:—The mud-tortoises of India have been properly divided into two species. He might have added, with truth and justice, that the species had been well characterized, and their synonymy well made out; but this would show the ridiculousness of the vain boast which terminates his paper. The species are so distinct that the native fishermen and market people know them by dif-